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13. ABSTRACT (Maximum 200 words)

Effort was concentrated on developing a database of oceanographic features seen in Earth photographs collected during the first ten years of the U.S. Space Shuttle program. The database contains information pertaining to each ocean and coastal photograph, including date, time location, camera/lens combination, film type, Shuttle mission, Shuttle altitude, sun inclination, and a series of two-letter acronyms that describe the oceanographic features visible within the photography. A preliminary analysis of the photography representing the Tropical Pacific was performed in an attempt to detect the presence of fronts associated with tropical instability waves. The fronts appear within the sunglint pattern as linear features and are visible on 8 deferent occasions since 1984. In each case, the features appear in the late boreal summer, fall, and early winter, when the tropical instability waves are the most intense. The most spectacular of these fronts was photographed on 7 August 1992 from an altitude of 230 km by the crew of the U.S. Space Shuttle Atlantis (NASA photo ID:S46-77-17). This same feature was observed several days later from a P-3 aircraft and from a research vessel at 140° W, both of which were conducting surveys as part of the Equatorial Pacific JGOFS program. (cont. on pg. 2)

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(cont. from pg. 1)

A paper discussing this feature appeared in the 20 October 1994 issue of Nature. In addition to scientific research, the PI participated in the NASA astronaut training program as in invited lecturer.

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FINAL REPORT

PROJECT TITLE: Distribution Of Oceanic Features Seen In Space Shuttle Photography

PRINCIPAL INVESTIGATOR AND PROJECT DIRECTOR:

Dr. Lewis S. Incze
Bigelow Laboratory for Ocean Sciences
McKown Point
West Boothbay Harbor, ME 04575

PERFORMANCE PERIOD: 01 June 1993 - 31 October, 1993

OBJECTIVES

The objective of this research is to identify open ocean and coastal water features appearing within photographs taken during U.S. Space Shuttle missions (1981-1991) and to investigate their geographic and temporal occurrences. In addition to a comprehensive review of these data, to be submitted for publication in a peer-reviewed journal, this work will culminate in a database of coastal and ocean photographic data that may be accessed with standard desk-top computer equipment and software. Bigelow Laboratory for Ocean Sciences will provide facility support and Dr. Steven G. Ackleson will perform the research.

BACKGROUND

Many physical and biological features are evident within photographs of the ocean taken by astronauts during U.S. Space Shuttle Missions (Soules, 1970; Stevenson, 1988; La Violette and Arnone, 1988; La Violette et al., 1990), e.g., internal waves, eddies, fronts, turbidity plumes, phytoplankton blooms, surfactants, and structures related to surface wind stress. During the past decade of Shuttle missions, astronauts have taken more than 29,500 informative photographs of the worlds oceans between 60°N and 60°S (Ackleson, 1992). Yet, as a consequence of an extremely limited number of viewing facilities, these potentially important data remain largely untapped and largely misunderstood by the oceanographic community.

In 1992, NASA produced a limited number of laser disks (50) containing digitized versions of all Space Shuttle Earth photography between 1981 and 1991. The photographs are easily viewed with the use of a PC-controlled laser disk reader. In addition, information pertaining to each photograph (e.g., acquisition date and time, Shuttle altitude, camera equipment, and area photographed) has been entered into the Space Shuttle Earth Observations (SSEOP) database. The SSEOP database may be easily perused within a PC environment. For the first time, it is possible to rapidly search the SSEOP database and view the photography in order to identify and locate important oceanographic features.

APPROACH

All work will be conducted at the remote sensing facilities of Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, Maine. Dr. Ackleson will identify high-quality photographs of ocean and coastal areas and identify ocean features. All pertinent information will be extracted from the SSEOP database and entered into a new ocean and coastal features (OCF) database.

In addition to the SSEOP data, character fields identifying ocean features will also be entered into the OCF database. The OCF database will then be used to investigate the global distribution and temporal occurrences of selected ocean features.

NASA will provide Dr. Ackleson, at no additional cost, a copy of the Space Shuttle photographic laser disk, the SSEOP database in DBASE IV format, duplicates of all Space Shuttle photography collected between 1981 and 1991, and all supporting documentation.

RESULTS & ACCOMPLISHMENTS

Work was concentrated on developing a database of oceanographic features seen in Earth photographs collected during U.S. Space Shuttle missions. The emphasis was on photography collected during the first ten years of the Shuttle program. This work involved setting up a photographic archive at the host institution, complete with 2nd generation film and a light table donated to the project by the U.S.G.S.. To date, approximately 1/3 of the database has been constructed. The database contains information pertaining to each ocean and coastal photograph, including date, time, location, camera/lens combination, film type, Shuttle mission, Shuttle altitude, sun inclination, and a series of two-letter acronyms that describe the oceanographic features visible within the photography.

A preliminary analysis of the photography representing the Tropical Pacific was performed in an attempt to detect the presence of fronts associated with tropical instability waves. The fronts appear within the sunglint pattern as linear features and are visible on 8 different occasions since 1984. In each case, the features appear in the late boreal summer, fall, and early winter, when the tropical instability waves are the most intense. The most spectacular of these fronts was photographed on 7 August 1992 from an altitude of 230 km by the crew of the U.S. Space Shuttle Atlantis (NASA photo ID: S46-77-17). The Shuttle was located at 1.5°N, 132.6°W and the sunglint pattern was centered at 2.1°N, 131.8°W. The front, oriented nearly north-south and extending the entire length of the photograph (approximately 57 km), defines the boundary between warm, stratified waters of the Tropical Pacific (west of the front) and relatively cool waters recently upwelled at the equator (East of the front). Small, low altitude cumulus clouds appear west of the front, forming cloud streets parallel with the dominant westerly winds and indicating the presence of warmer surface water. This same feature was observed several days later from a P-3 aircraft and from a research vessel at 140°W, both of which were conducting surveys as part of the Equatorial Pacific JGOFS program. A paper discussing this feature, including the Space Shuttle data, recently appeared in Nature (Yoder et al, 1994). In addition, one of the Shuttle photographs appeared on the cover of Nature.

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